FMPO
Regional Transportation Model

Transportation Model Improvement Program
FMPO Peer Review
Transportation Modeling and the TIA Process
September 14 and 15, 2015

Introduction

- The purpose of this presentation is to familiarize the audience with the FMPO Regional Transportation Model, so they may judge how it may better be used in the Transportation Impact Analysis (TIA) process.
- The City of Flagstaff – and later the FMPO – have maintained a regional traffic model since the early 1990's starting with TranPlan and then transitioning to TransCAD in 1998.
- "3D" modeling, introduced to the model for the 2009 Regional Transportation Plan update, enabled the FMPO to improve calibration by accounting for non-auto demand.
- A recent advancement, bicycle assignment, allows examination of bicycle facilities in the service of mobility and mode shift.
- The model has been used to support traffic impact analysis (now transportation impact analysis) for some time. TIA uses:

<u>Primary</u>
- Distribution
- Assignment

<u>Informing</u>
- Generation
- Internal Capture

<u>Informing (Occasional)</u>
- Mode share
- Turn movement
  - Order of Magnitude

Key Questions

- Generally:
  - What are the best ways to apply the different stages of the modeling process to the different expectations out of the TIA process? OR
  - Where in the TIA process are applications of the model most limited and how are these best explained to and mitigated by the local jurisdiction and development applicant?
- More specifically:
  - What level of calibration or validation are needed to apply the model in "deeper" phases of the TIA process?
  - How might the model or other means best be used to direct private investments in pedestrian, bicycle and transit infrastructure and services?
  - What are the most appropriate horizon years and land use and network assumptions to make within the TIA process?
  - How can the model best be used to inform "proportional share" discussions?

FMPO Location Map

Flagstaff is

150+/- miles

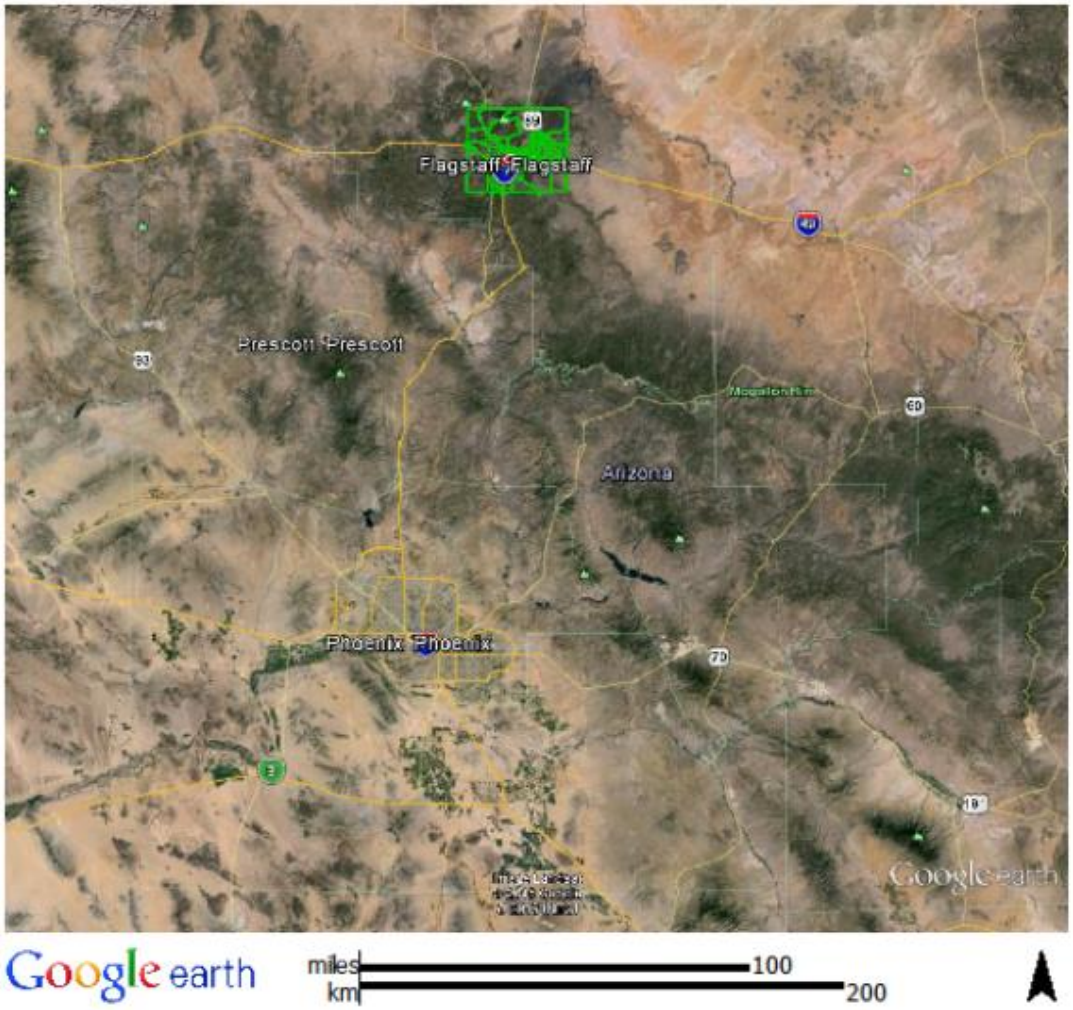
north of Phoenix at the intersection of Interstates 40 and 17.

Population:

85,000 region

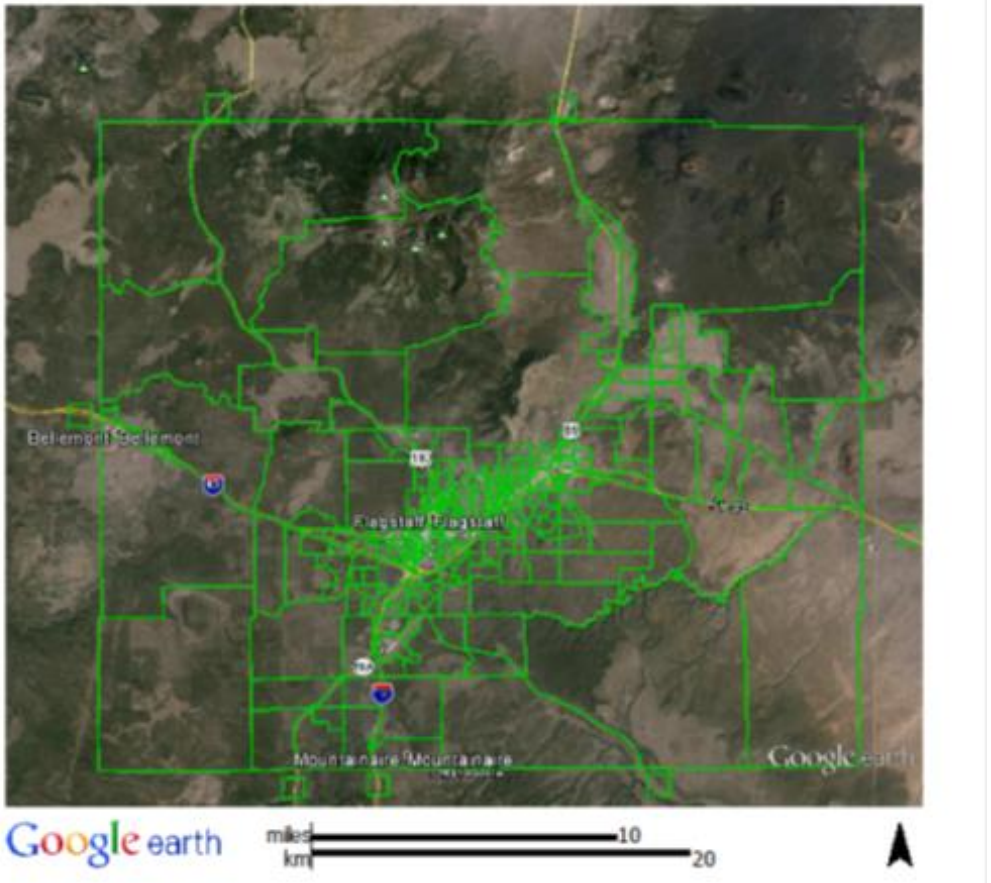
68,000 city

20,000 NAU



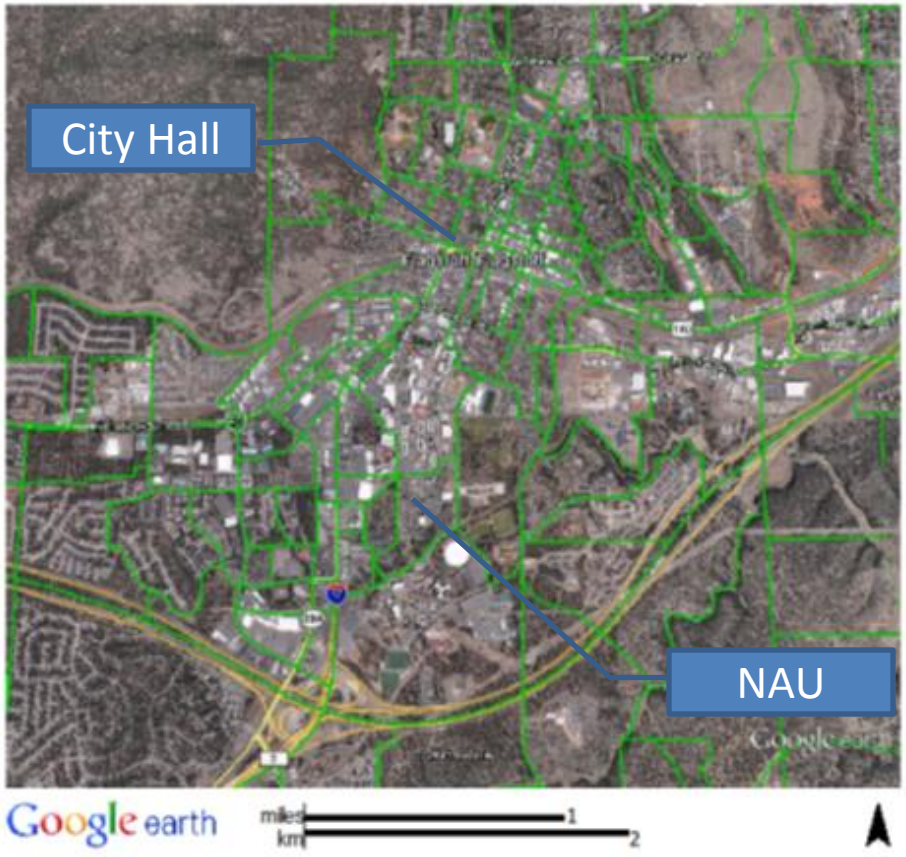
FMPO Region View

FMPO is 525 square miles. The model contains 373 Traffic Analysis Zones (TAZ) including 8 external Stations and 10 reserved for purposes like TIAs. Public lands are segregated. Census geography is approximated where practical.



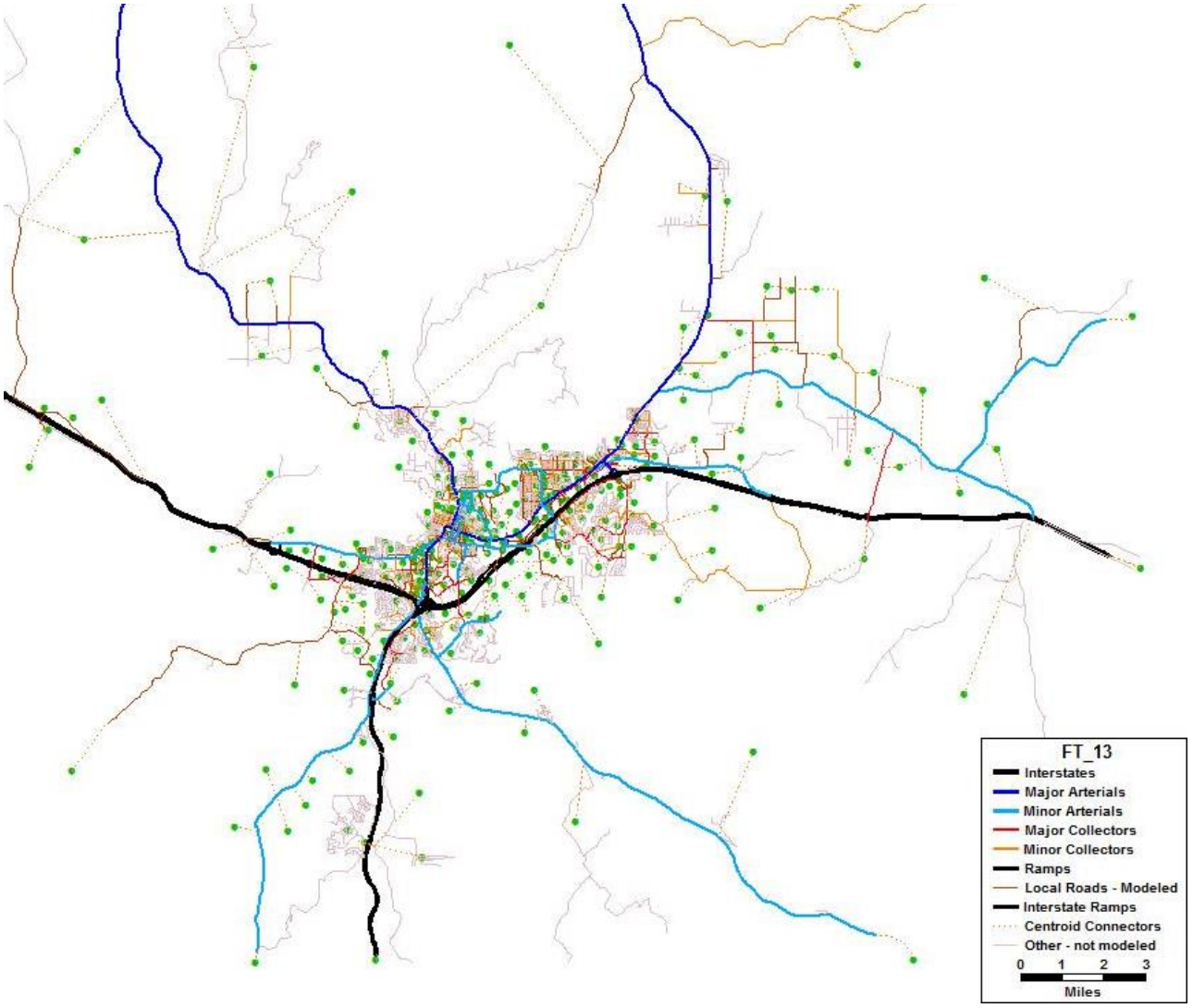
FMPO Core View

TAZs get considerably smaller in the core. Northern Arizona University is divided into three TAZs. It enjoys a separate trip purpose (HBU). It also has an attraction land use based on students and an additional production use for on-campus housing.



FMPO Network

Facility types range from interstates to occasional local roads. Local roads are sometimes modeled where fully represented intersections are desired.



Network Data

ID	455
Length	0.515085042
Dir	0
OBJECTID	571
STREETID	571
FULLNAME	E CEDAR AVE
PREFIXDIRE	E
STREETNAME	CEDAR
STREETTYPE	AVE
SUFFIXDIR	
FUNCTIONAL	Minor Arterial
SPEED	40
OvrLen	
FT	3
ABAT	1
BAAT	1
ABLANES	2
BALANES	2
AB_FF	45
BA_FF	45
PAVED	1
ABPARK	0
BAPARK	0
AdjLength	
ST_CODE	069
OWNER_CODE	0
CNT_ST_COD	182
ADOT_AADT	
ADOT_FUNC	
ADOT_PWDT	
COUNTSEST	17000
BASE_FLOW	20675.35857
DO_NCHRP	1
SC_LINE	
DATASOURCE	08GIS
chng_01_04	
chng_desc	

ABCAPACITY	17600
BACAPACITY	17600
AB_HRCAP	1584
BA_HRCAP	1584
ABFFTIME	0.686780095
BAFFTIME	0.686780095
Alpha	10
Beta	7
DIST	0.515085042
AB_biketime	2.575425208
BA_biketime	2.575425208
AB_bikecap	10000
BA_bikecap	10000
AB_walktime	10.30170083
BA_walktime	10.30170083
AB_walkcap	10000
BA_walkcap	10000
AB_PMCNT	952
BA_PMCNT	631
2007_24_T	
2007_24_AB	
2007_24_BA	
2010_24_T	18383
2010_24_AB	9249
2010_24_BA	9134
2013_24_T	17828
2013_24_AB	8982
2013_24_BA	8846
2013_PM_T	1583
2013_PM_AB	952
2013_PM_BA	631
ABOvCap_13	
BAOvCap_13	
ABOvCap	
BAOvCap	
Bus	1
UA	1

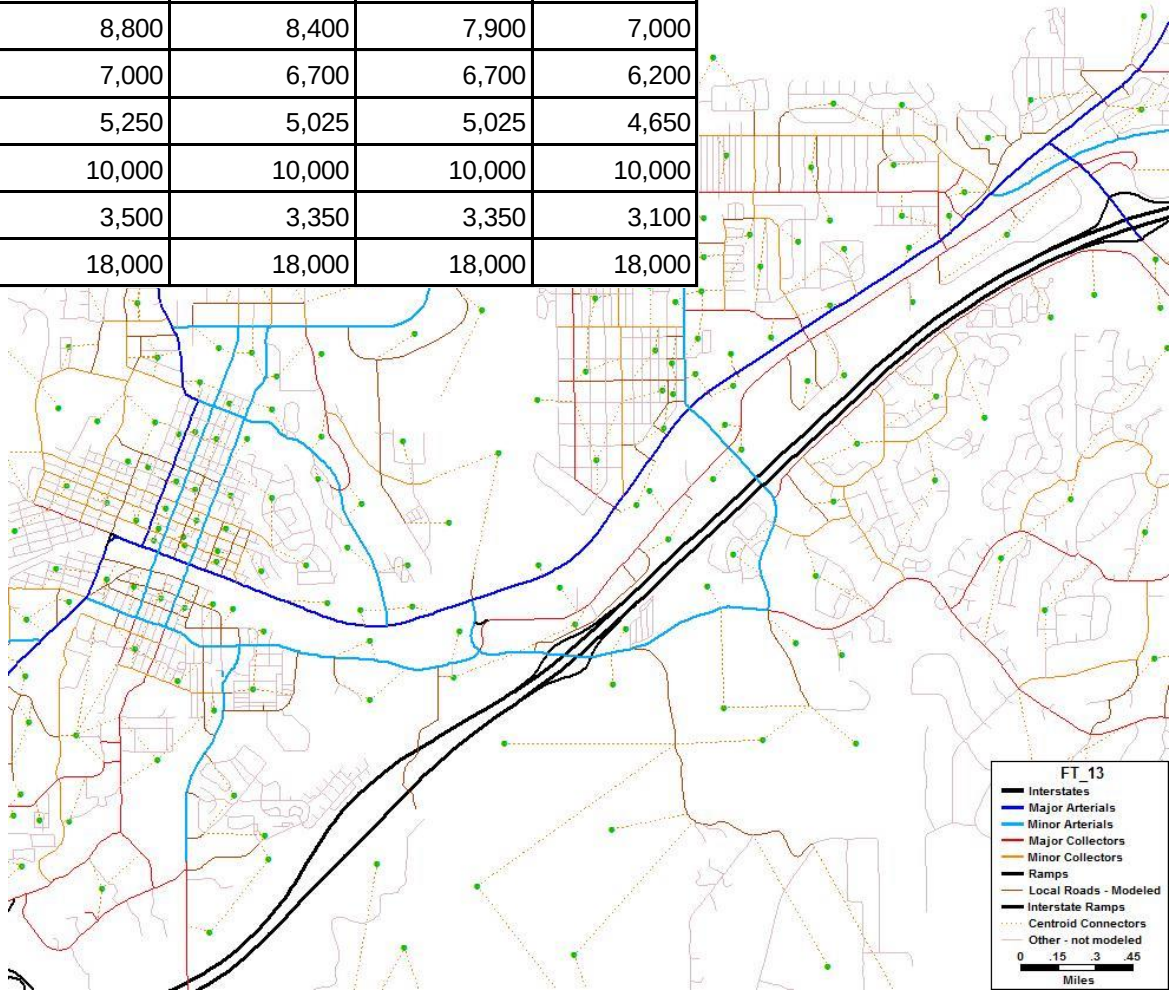
- Network geography is primarily from local GIS files. Length is derived from this data.
- Directional data (AB/BA) are maintained for a variety of features: Area Type (AT), Lanes, Free flow speed (FF), Paving, and Parking and historic and current traffic counts (24 hr. and PM)
- General data such as direction (1-way, 2-way), ownership, whether the segment is a count location or on a screenline
- Several fields are calculated such as capacity and time
- Alpha and Beta are part of the Delay Function – this determines how fast different facilities congest. FMPO employs a conical delay function.

FMPO Model Network

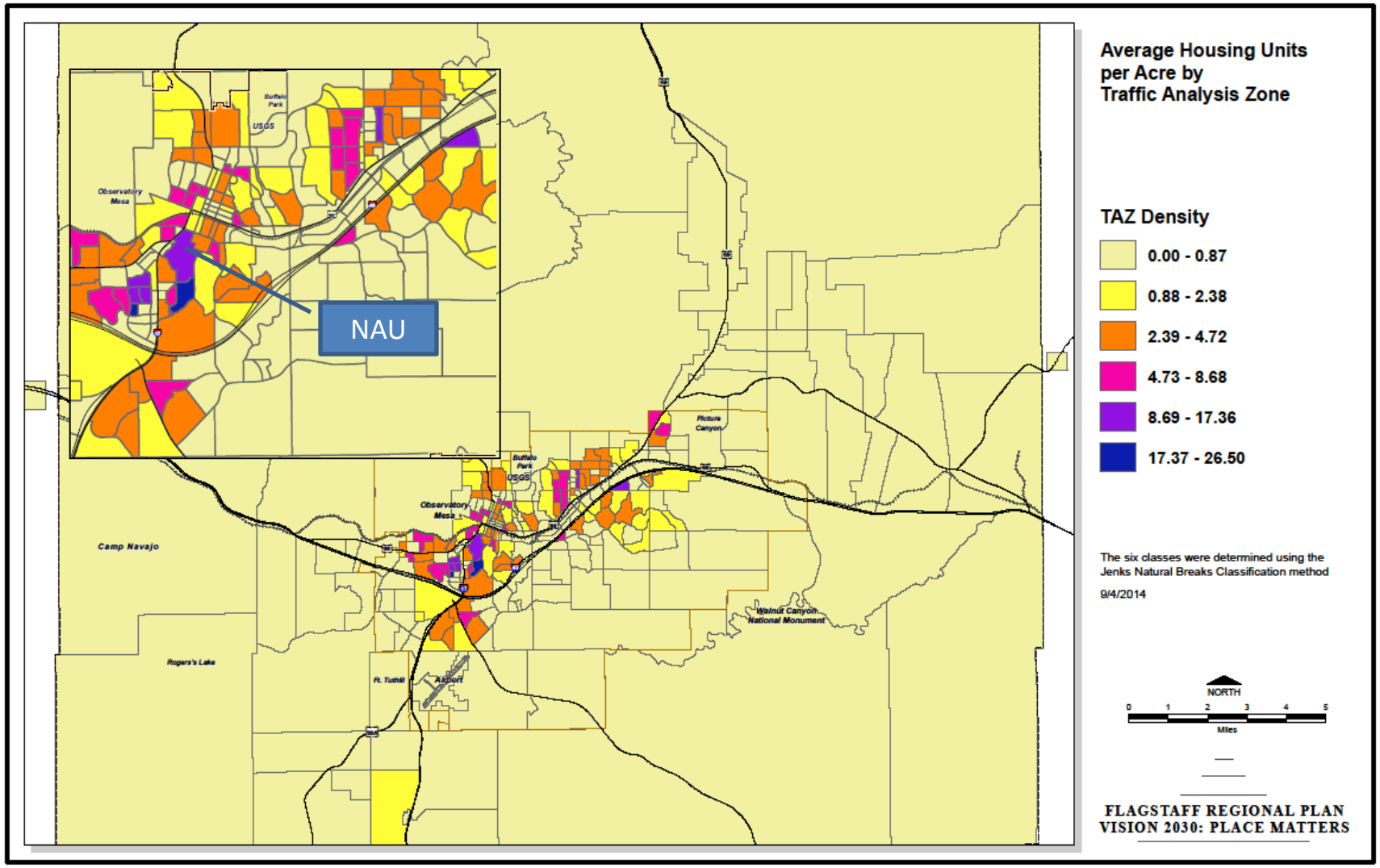
Facility Type	Rural	Residential	N.Com.	Hvy. Com.	CBD
Freeway	20,000	20,000	20,000	20,000	20,000
Major Arterial	11,700	11,700	11,700	10,000	9,000
Minor Arterial	8,800	8,800	8,400	7,900	7,000
Major Collector	7,000	7,000	6,700	6,700	6,200
Minor Collector	5,250	5,250	5,025	5,025	4,650
Ramp	10,000	10,000	10,000	10,000	10,000
Local	3,500	3,500	3,350	3,350	3,100
Fwy / Fwy Ramp	18,000	18,000	18,000	18,000	18,000

Facility capacities change by area type to represent side friction among other things.

Some centroid connectors “float” ahead of connections to future roads.



Land use: Housing density



Land use: Trip Rates

Trip rates are based on ITE trips rates with some modifications.

Land use quantities are derived from County Assessor's data.

ID 31 Wilderness captures recreation activity.

Uses in yellow are no longer broken out in the model. The "3D" process adjusts for downtown rates.

A vacancy table adjusts school, hotel and some retail quantities for fall vs. summer condition.

MODEL_ID	LU_DESCRIP	UNITS	DAYRATE
1	Single Family Detached	DU	9
2	Single Family Attached	DU	5.86
3	Multi Family/Apartment	DU	6.5
4	Nursing home	Beds	2.61
5	Mobile Home Park	DU	6
6	Free-Standing Discount S	1k SF	49.2
7	Downtown Coffee Shop	1k SF	100
8	Downtown Restaurant	1k SF	69
9	Downtown Office	1k SF	10
10	Hotel/Motel	Rooms	8
11	Medical Office	1k SF	30
12	New Car Sales	1k SF	37.5
13	Mobile Home Dealer	1k SF	30
14	Fast Food/Drive Thru	1k SF	350
15	Coffee Shop	1k SF	140
16	High Turnover Restaurant	1k SF	79
17	Office	1k SF	11.7
18	Neigh./Specialty Commerc	1k SF	35
19	Shopping Center/Discount	1k SF	41.8
20	Movie Theater	1k SF	78.06
21	Wholesale Distributor	1k SF	4.96
22	Downtown Commercial	1k SF	25
23	Downtown Government Offi	1k SF	30
24	Post Office	1k SF	108
25	Heavy Industrial	1k SF	3.82
26	Light Industrial	1k SF	6.97
27	S.F. Detached - 2nd Home	DU	5.4
28	S.F. Attached - 2nd Home	DU	4.5
29	Multi-Family - 2nd Home	DU	3.9
30	Neighborhood/City Park	Acre	1.3

MODEL_ID	LU_DESCRIP	UNITS	DAYRATE
31	Wilderness	Acre	0.01
32	Golf Course	Acre	4.5
33	Jr. High School	Students	1.3
34	Government Office	1k SF	20
35	Utility Substation	Acre	2
36	Civic Center/Museum/Gall	1k SF	25
37	Preschool/Day Care	1k SF	79.26
38	Elementary School	Students	0.85
39	Fire Station	ak SF	10
40	Library	1k SF	42
41	Mini-Storage	1k SF	1.4
42	Church	1k SF	18.22
43	Kachina Village Area	DU	4
44	Hospital	ak SF	18.45
45	Athletic Club	1k SF	22.8
46	Private School	1k SF	12
47	Civic Organization/Lodge	1k SF	20
48	Warehousing/Nursery	1k SF	4
49	Stables/Equine Facility	1k SF	20
50	Gravel/Sand/Cinder Pit	Acre	2
51	Truck Terminal	Acre	80
52	Campground/R.V. Park	Acre	2
53	Junk/Salvage	Acre	2
54	Flagstaff Mall	1k SF	44.1
55	Airport	Comm Fli	150
56	NAU	Students	2.38
57	Sr. High School	Students	2
58	NAU Residential	DU	3.5
59	Convenience Store	1k SF	275
60	Other	N/A	0

Trip Generation: Productions/Attractions/Purposes

Unbalanced Trip Generation Results

	HBW	HBU	HBO	HBS	NHB	Total
Productions	66,272	25,335	83,598	72,784	140,714	388,703
Attractions	61,908	36,485	78,509	77,476	137,290	391,668
Total	128,181	61,821	162,107	150,260	278,004	780,371

Balanced Trip Generation Results

	HBW	HBU	HBO	HBS	NHB	Total
Productions	66,272	36,485	83,598	72,784	140,714	399,853
Attractions	66,272	36,485	83,598	72,784	140,714	399,853
Total	132,544	72,971	167,196	145,568	281,427	799,706

- FMPO uses five purposes (HB = Home-based)
- Attractions are balanced to productions assuming productions are more accurate. Except for University trips where the number of students as an attraction are deemed more accurate.

Model Output
Trip lengths and Totals by Purpose

Average Trip Lengths

	HBW	HBU	HBO	HBS	NHB	Total
Miles	5.8	1.9	3.4	3.5	3.8	3.8
Minutes	9.5	4.1	6.2	6.0	6.7	6.7
Speed	36.9	27.8	32.6	34.7	34.1	34.2

Modeled Trip Totals

	HBW	HBU	HBO	HBS	NHB	Total
Intrazonal	244.2	8,472.7	2,499.3	1,293.1	1,883.5	14,392.8
Interzonal	66,028.0	28,012.7	81,098.6	71,491.0	138,830.1	385,460.4
Total	66,272.2	36,485.4	83,597.8	72,784.1	140,713.6	399,853.1
% Intrazonal	0.4	23.2	3.0	1.8	1.3	3.6

FMPO does not calibrate to speed and distance beyond a general reasonableness check.

Person Trips

- Underlying automobile trips are expanded in the 3D model to person trips and used to calculate mode share.
- All auto trip productions and attractions are multiplied by 1.055. The starting point for this factor was the number of non-auto trips reported in the household trip survey
- Then a second set of multipliers is applied to adjust for average auto occupancy to convert auto trips to person trips (based on 2000 Census data for work trips and the household trip diary survey for the other trip types):
  - Home-Based Work (HBW): 1.24
  - Home Based University (HBU): 1.5
  - Home-Based Other (HBO): 1.5
  - Home-Based Shopping (HBS): 1.5
  - Non-Home-Based (NHB): 1.35
- Once non-auto person trips are removed, the process is reversed and the automobile model is run.

3D Model: Non-Auto Person Trip Distribution

- The model includes **density**: housing and employment input as home-based work trips productions (HBWP) and attractions (HBWA).
- **Design** is addressed by including separate ped, bike and transit level-of-service variables.
- **Diversity** is accounted for implicitly in the model, as there must be both productions and attractions in the same area to get walk/bike trips.
- Other variables include dummy variables for NAU and for non-home-based trips.
- In the Flagstaff region, the model has much more detail and smaller TAZs, particularly in the downtown, so, intrazonal and interzonal walk/bike trips are included.
- There is a negative constant indicating a low walk/bike mode share with no density and outside NAU. There also is a more negative constant for non-home-based trips. This prevents the model overestimating non-motorized NHB trips in car-oriented trip chains.

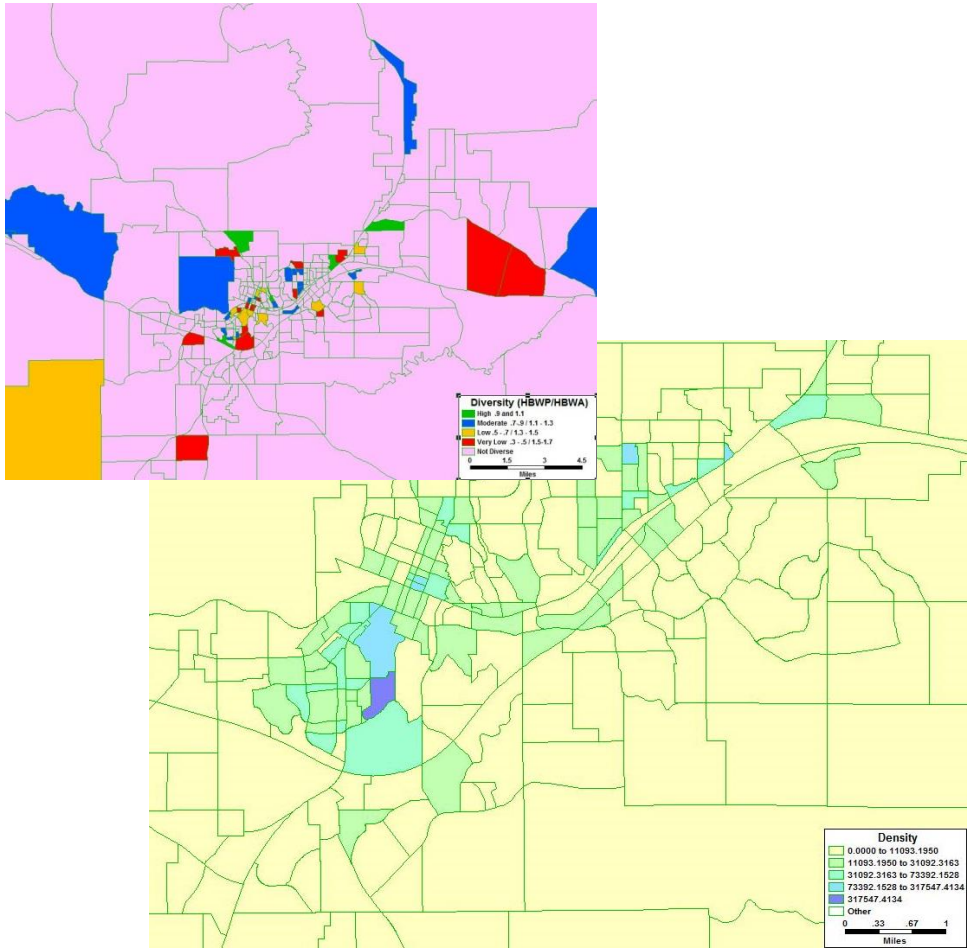
constant	-1.2
Constant in NHB model	-1.7
NAU campus (origin TAZ)	.5
NAU campus (destination TAZ)	.5
SQRT(HBWP/sq mi) – origin TAZ	0.0004
SQRT(HBWP/sq mi) – destination TAZ	0.0004
SQRT(HBWA/sq mi) – origin TAZ	0.0001
SQRT(HBWA/sq mi) – destination TAZ	0.0001
Net pedestrian LOS – origin TAZ	.03
Net pedestrian LOS – destination TAZ	.03
Bicycle LOS – origin TAZ	.015
Bicycle LOS – destination TAZ	.015

3D: density, diversity & design
DENSITY & DIVERSITY

- Density = HBW trips per TAZ area. The density variables are in terms of the square root of density per mile. This formation has worked well consistently in past work (by the consultant), and builds in diminishing returns from adding density.
- Diversity = balance of HBW-attraction vs. HBW-production. Adding other purposes had little effect.

Question:

- Does TAZ size inadvertently affect the diversity component?

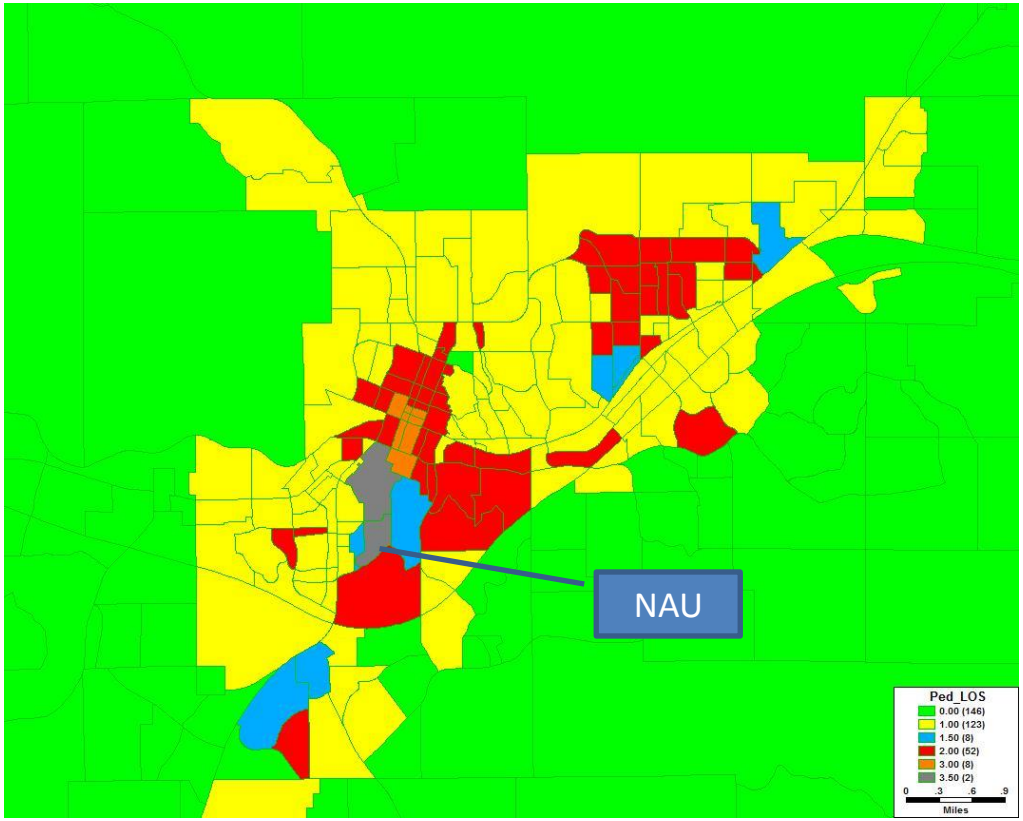


3D: density, diversity & design
DESIGN

- The model includes design through the inclusion of separate pedestrian, bicycle and transit level-of-service variables.
- LOS scores, to date, are subjective or "empiridotal"
- Walk person trips are subtracted from overall person trips, resulting in vehicle person trips, which are split between transit and auto and then auto and bike in subsequent model steps.

Pedestrian LOS & Ped share

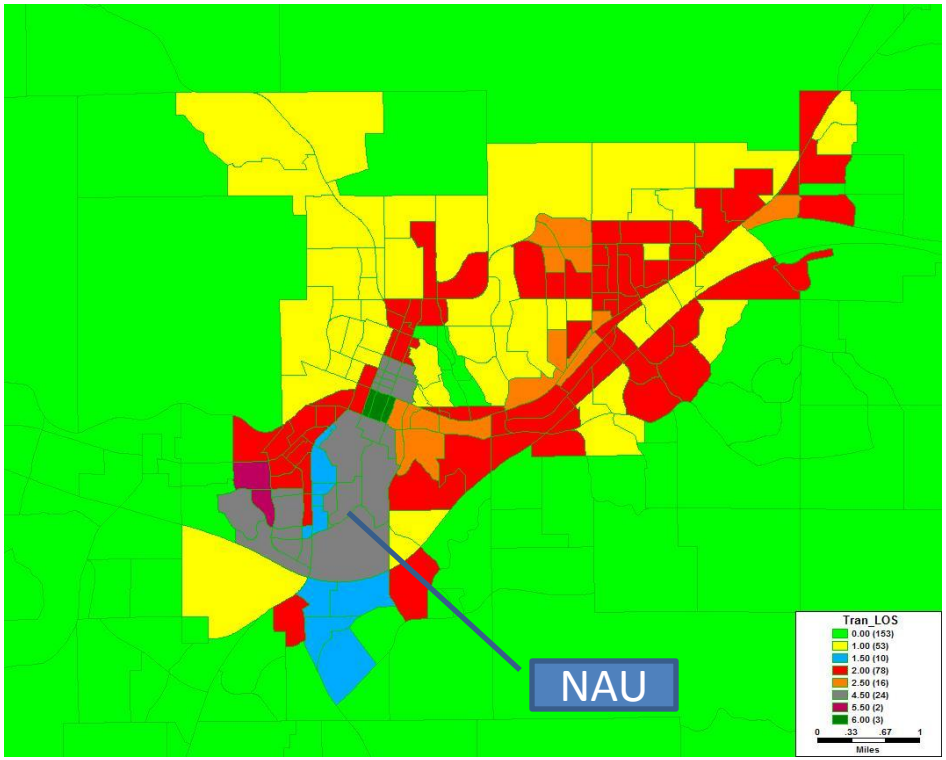
- The pedestrian level of service is relative to the area type; i.e. a “2” in an urban area implies a higher level of service than a “2” in a suburban area, effectively weighting score based on area type.
- Walk shares are adjusted downward for TAZs that are more than 1 square mile in size; the larger the area, the greater the adjustment.



- Pedestrian LOS Variables (qualitative now, quantitative in development): Missing sidewalks, street or intersection density, crossing or cross-walk density weighted by type

Transit LOS & Transit Share

- The bus model assumes walkability on both ends of the trip is an important to transit usage as is the bus level of service. It is assumed that the bus system is connected, i.e. that there is a reasonable bus trip between any two TAZs with bus service.
- Transit LOS Variables: Proximity to bus stops (1/4 and 3/8 mile); Frequency of service

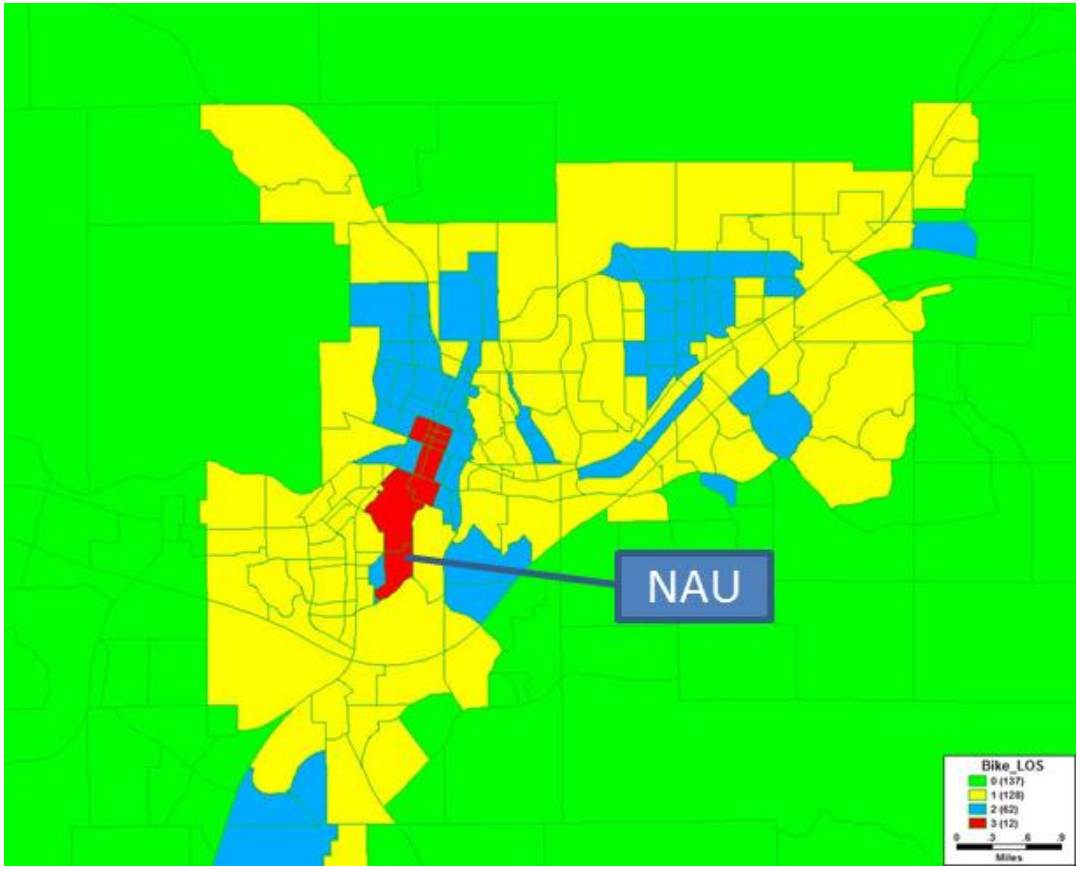


Transit Share = busShareMult * Tran_Shares.mtx * (BusLOS_Origin/3) * (BusLOS_Destination/3)

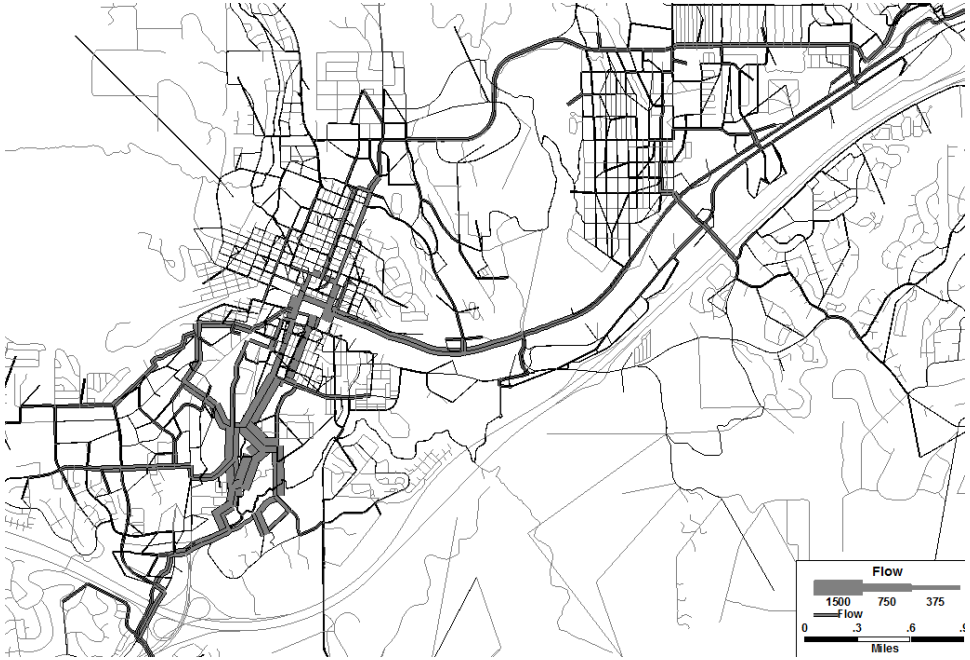
Distance adjustment: if ijLength <= 2 then Tran_Shares = Tran_Shares * (ijLength/2)^2 if ijLength > 2 then Tran_Shares = Tran_Shares * (1 + log10 ((ijLength/2)^2))

Bike LOS & Bike Share

- Bike LOS is no longer a determinant of bike share.
- "Cost" of bike travel vs. auto travel is now determinant of share. Bike cost is based on distance weighted by Bicycle Comfort Index (BCI). Auto travel is by travel time.
- Bike LOS may still be used to evaluate policy implications.
- Bike LOS Variables: BCI, Crossings, Street or intersection density, missing links



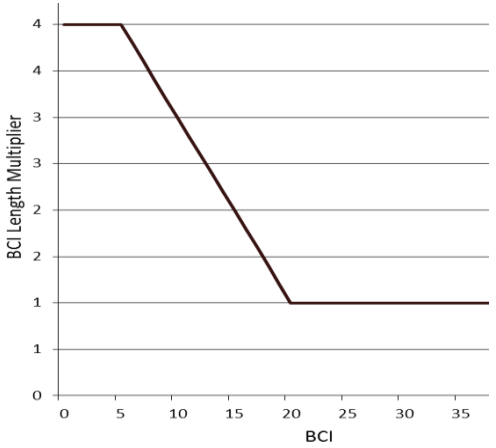
Bike Assignment



- Bike LOS removed from Walk Model
- Walk model constants decreased to lower walk-only mode share
  - Changed for most trips from -1.2 to -1.7
  - Changed for non-home-based trips from -1.7 to -2.2
- Transit multiplier increased to restore transit mode share from 0.255 to 0.32 (because transit mode share function of walk mode share)

Bicycle Comfort Index "Distance" Adjustments

- BCI = Traffic speed & volume, bike lanes and trails, lane widths, etc.
- Best multiplier 1.0
- Achieved at BCI >= 20
- Slope of increase below BCI 20 0.2 per unit
- Maximum multiplier 4.0
- AB_BCI_adj/BA_BCI_adj manual multiplier adjusts output (default 1.0), e.g. 2.0 on Leroux, Kendrick & Sitgreaves to shift bikes to Beaver which has lower BCI



Automobile Assignment

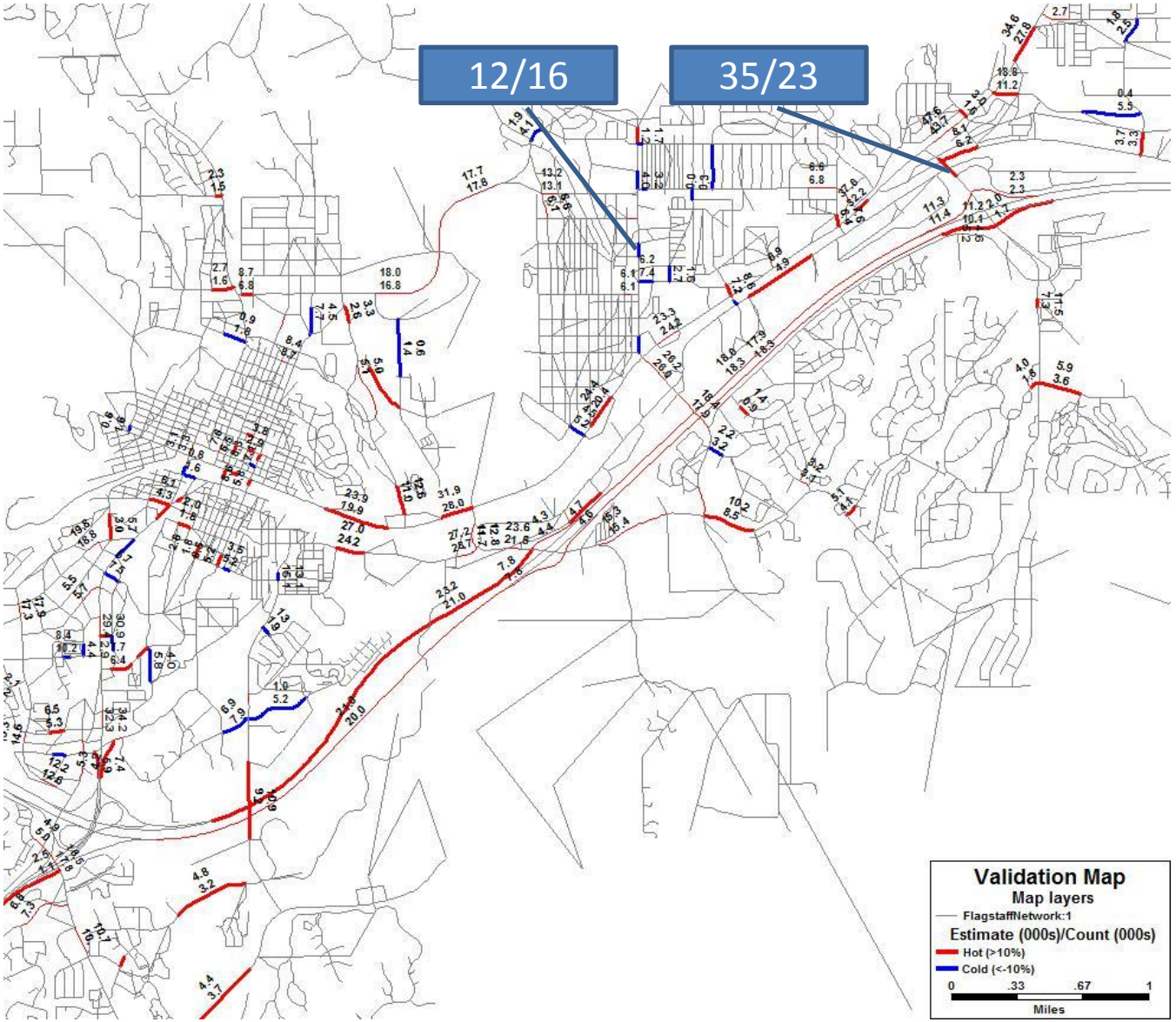
- Assignment uses a Stochastic User Equilibrium (SUE) model that allows for some amount of randomness. This accounts for the fact that users do not have perfect information about the network.
- Networks are coded for directionality: 0=2-way; -1=1 way against topology; +1=1way with topology.
- Turn penalties and restrictions are employed where turns are prohibited or where delays are known or suspected to be longer than “typical.”
- A THROUGH-MOVEMENT DELAY IS USED ACROSS THE RAILROAD TRACKS TO APPROXIMATE TRAIN ACTIVITY.

Calibration

The model generally calibrates well – in the 18-21% RMSE.

Two areas are perpetually inaccurate.

- Fourth Street always low
- Country Club always dramatical-ly high.



Calibration: Links and Counts

Number of Links with Counts

	Rural	Residential	Neigh. Comm.	Heavy Comm.	CBD	Total
Freeway	10	4	--	--	--	14
Major Arterial	9	2	3	3	3	20
Minor Arterial	17	10	9	5	4	45
Major Collector	8	11	17	6	--	42
Minor Collector	2	26	3	2	4	37
Ramp	8	3	4	0	--	15
Local Streets	1	6	1	8	0	16
Interchange Ramps	0	--	--	--	--	0
Total	55	62	37	24	11	189

Number of Links

	Rural	Residential	Neigh. Comm.	Heavy Comm.	CBD	Total
Freeway	51	22	--	--	--	73
Major Arterial	66	32	30	15	21	164
Minor Arterial	113	60	71	42	27	313
Major Collector	51	122	102	26	--	301
Minor Collector	35	356	27	8	41	467
Ramp	48	4	6	2	--	60
Local Streets	55	251	60	25	28	419
Interchange Ramps	10	--	--	--	--	10
Total	429	847	296	118	117	1,807

Calibration: VMT and Volume

Modeled VMT / Count VMT

	Rural	Residential	Neigh. Comm.	Heavy Comm.	CBD	Total
Freeway	97.9%	101.4%	--	--	--	99.3%
Major Arterial	102.0%	137.8%	107.1%	101.2%	99.0%	103.7%
Minor Arterial	94.1%	97.8%	100.1%	92.8%	123.3%	95.6%
Major Collector	104.5%	97.5%	101.6%	114.6%	--	102.7%
Minor Collector	127.7%	96.3%	93.5%	24.4%	102.3%	87.5%
Ramp	102.0%	118.3%	101.5%	--	--	103.5%
Local Streets	90.1%	56.9%	61.3%	84.0%	--	70.3%
Interchange Ramps	--	--	--	--	--	--
Total	98.2%	101.0%	102.1%	94.4%	103.9%	99.2%

Modeled Volume / Count Volume

	Rural	Residential	Neigh. Comm.	Heavy Comm.	CBD	Total
Freeway	99.2%	101.6%	--	--	--	100.3%
Major Arterial	104.9%	127.1%	103.5%	102.2%	101.3%	105.1%
Minor Arterial	93.4%	97.0%	97.0%	93.0%	123.4%	96.7%
Major Collector	98.3%	91.0%	98.2%	110.8%	--	98.4%
Minor Collector	130.0%	90.4%	83.8%	40.9%	106.2%	89.0%
Ramp	102.2%	117.5%	102.9%	--	--	105.2%
Local Streets	90.1%	67.8%	61.3%	85.4%	--	78.2%
Interchange Ramps	--	--	--	--	--	--
Total	100.5%	97.9%	98.5%	96.9%	106.5%	99.2%

Calibration: % Volume and RMSE

Percent Volume Error

	Rural	Residential	Neigh. Comm.	Heavy Comm.	CBD	Total
Freeway	-0.8%	1.6%	--	--	--	0.3%
Major Arterial	4.9%	27.1%	3.5%	2.2%	1.3%	5.1%
Minor Arterial	-6.6%	-3.0%	-3.0%	-7.0%	23.4%	-3.3%
Major Collector	-1.7%	-9.0%	-1.8%	10.8%	--	-1.6%
Minor Collector	30.0%	-9.6%	-16.2%	-59.1%	6.2%	-11.0%
Ramp	2.2%	17.5%	2.9%	--	--	5.2%
Local Streets	-9.9%	-32.2%	-38.7%	-14.6%	--	-21.8%
Interchange Ramps	--	--	--	--	--	--
Total	0.5%	-2.1%	-1.5%	-3.1%	6.5%	-0.8%

% Root Mean Square Error

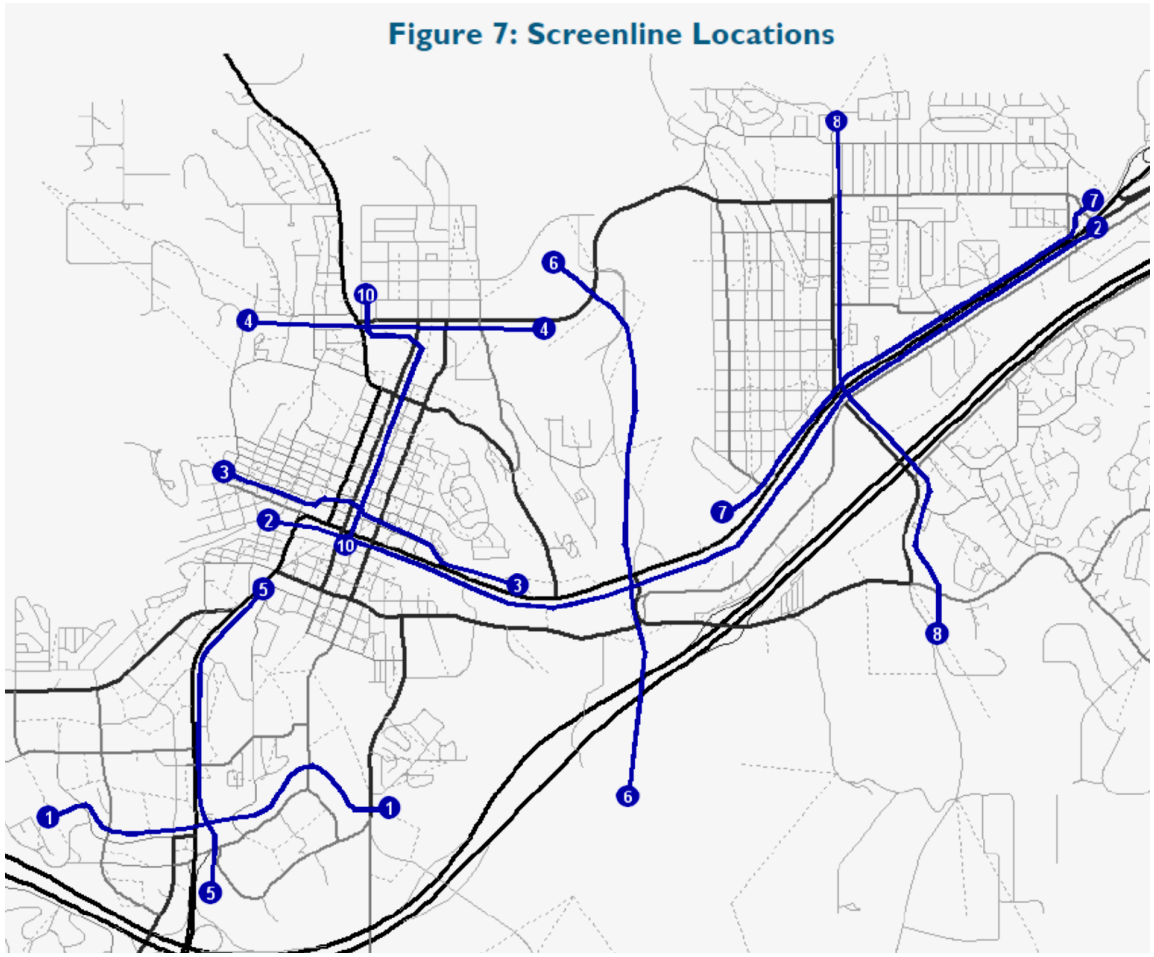
	Rural	Residential	Neigh. Comm.	Heavy Comm.	CBD	Total
Freeway	6.2%	5.8%	--	--	--	5.9%
Major Arterial	14.3%	58.4%	11.6%	15.1%	20.4%	16.5%
Minor Arterial	14.2%	4.9%	16.0%	8.7%	31.3%	12.3%
Major Collector	33.7%	21.1%	17.0%	31.6%	--	21.9%
Minor Collector	43.2%	33.3%	42.7%	124.6%	40.0%	43.7%
Ramp	11.1%	21.9%	10.3%	--	--	12.0%
Local Streets	--	54.2%	--	31.5%	--	37.9%
Interchange Ramps	--	--	--	--	--	--
Total	16.4%	24.7%	16.0%	19.7%	25.7%	20.0%

Calibration: Screenlines

Screenline Summary

Screenline	Model Volume	Count Volume	Model/ Count
Screenline 1*	61,460	64,537	95.2%
Screenline 2*	134,232	128,704	104.3%
Screenline 3*	43,295	41,546	104.2%
Screenline 4	29,634	32,638	90.8%
Screenline 5*	42,650	48,639	87.7%
Screenline 6*	120,352	114,519	105.1%
Screenline 7*	49,526	50,230	98.6%
Screenline 8*	92,364	101,248	91.2%
Screenline 9*	47,674	41,609	114.6%
Total	621,188	623,670	99.6%

* Missing at least one count on 8 screenlines



Calibration: Alternate Modes

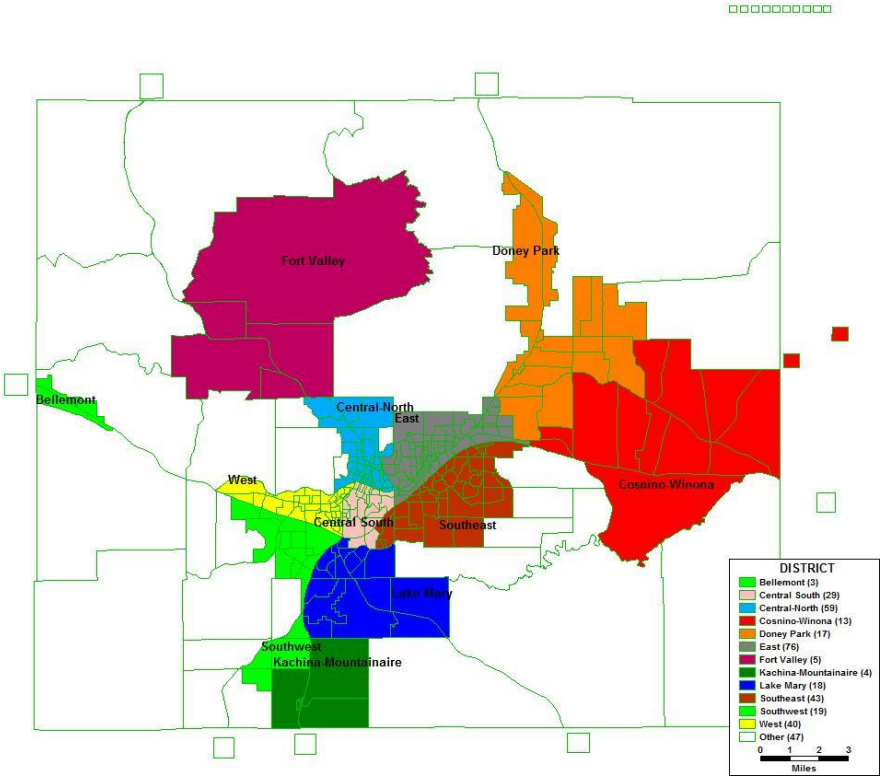
Mode Share Comparisons between the Regional Modal and Trip Diary Survey										
	Bike		Walk		Transit		B/W		W/T	
	TDS	Model	TDS	Model	TDS	Model	TDS	Model	TDS	Model
Overall	6	3.8	12.3	7.7	3.4	1.7	49%	49%	362%	453%
Core	14	6.5	32.5	13.5	11.3	3.5	43%	48%	288%	386%
Rest of Flag (RoF)	4.2	2.8	5.9	5.9	0.4	1	71%	47%	1475%	590%
Rest of FMPO	1	1	3.1	1.2	0.5	0	32%	83%	620%	n/a
Overall/Core	43%	58%	38%	57%	30%	49%				
Overall/RoF	143%	136%	208%	131%	850%	170%				
Overall/RoFMPO	600%	380%	397%	642%	680%	n/a				
Core/RoF	333%	232%	551%	229%	2825%	350%				
TDS = Trip Diary Survey			Core – Downtown, Southside and NAU				B/W = Bike divided by Walk			

Shares within modes and proportions between modes compare favorably.

- Relatively small mode shares make calibration and accuracy more challenging
- The model uses all trips – including trips passing through the region – as the denominator. The Trip Diary Survey does not. So, the modal share in the model should be smaller.

Calibration: Transit

- In August 2011, NAIPTA launched the Mountain Link. Before and after data for boarding, alighting and origin-destination were gathered and used to calibrate and validate the FMPO model.
- Data were aggregated by Traffic Analysis Zone and further aggregated by the districts illustrated to the right.
- The tables on the following slide show how well the model reflected interaction between districts.
- Large percentage differences are largely due to “small base” issues. Some discrepancies are attributed to spatial mismatch between bus routes and TAZs
- Absolute numbers:
  - Summer ridership – Data/Model: 3576/3585
  - Spring ridership – Data/Model: 6634/7214



Calibration: Transit

SPRING	PERCENT	Central South	Central North	Doney Park	East	Lake Mary	South-east	South-west	West	
		2	3	5	6	9	10	11	12	Total
Central South	2	47%	-7%	100%	-17%	-92%	-75%	19%	12%	14%
Central North	3	33%	-128%	na	-85%	15%	-86%	na	-322%	-44%
Doney Park	5	na	na	na	100%	100%	na	na	na	100%
East	6	13%	-12%	na	-33%	na	-162%	58%	-34%	-18%
Lake Mary	9	-29%	-70%	na	92%	na	na	na	25%	36%
Southeast	10	13%	9%	na	-14%	na	-53%	97%	-87%	4%
Southwest	11	7%	na	na	27%	na	na	na	-5%	-22%
West	12	25%	-661%	na	-164%	50%	-199%	-206%	-311%	-37%
	Total	29%	-63%	100%	-31%	6%	-105%	-4%	-36%	-9%

SUMMER	PERCENT									
		2	3	5	6	9	10	11	12	Total
Central South	2	8%	-47%	100%	38%	4%	45%	23%	43%	23%
Central North	3	10%	-202%	na	-77%	49%	-54%	na	-182%	-73%
Doney Park	5	na	na	na	100%	na	na	na	na	100%
East	6	46%	-17%	na	-41%	79%	-117%	56%	17%	-2%
Lake Mary	9	58%	-1%	na	94%	na	na	na	58%	71%
Southeast	10	65%	31%	na	10%	na	54%	na	16%	40%
Southwest	11	-5%	na	na	29%	na	na	100%	-60%	-37%
West	12	42%	-282%	na	-150%	62%	-26%	-125%	-85%	-26%
	Total	35%	-73%	100%	-12%	49%	-8%	-18%	3%	0%

P.M. Model Calibration Statistics

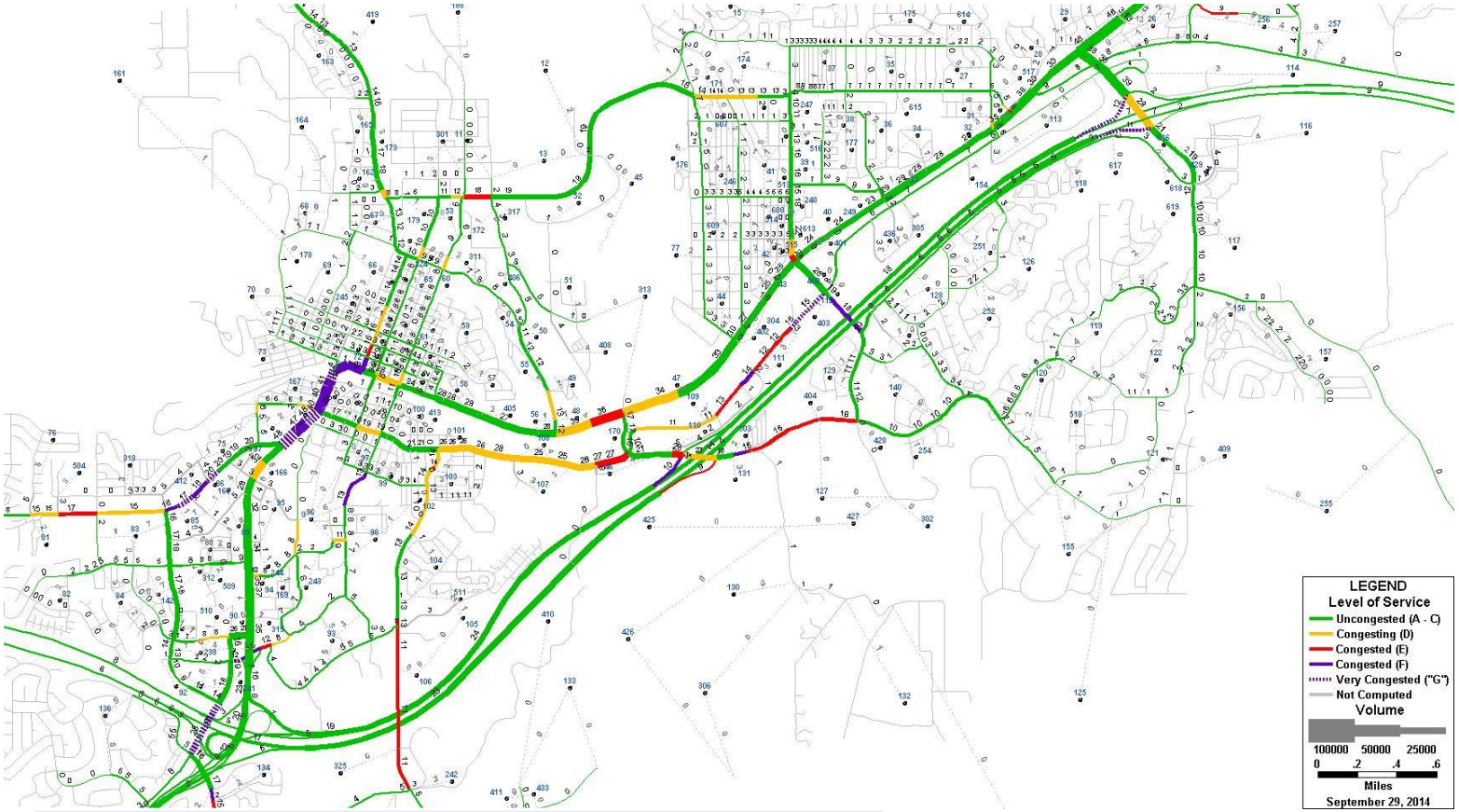
P.M. % Root Mean Square Error

	Rural	Residential	Neigh. Comm.	Heavy Comm.	CBD	Total
Freeway	21.8%	11.6%	--	--	--	16.0%
Major Arterial	12.3%	48.3%	12.0%	16.3%	24.1%	16.2%
Minor Arterial	25.1%	22.9%	36.4%	18.1%	19.0%	27.2%
Major Collector	32.8%	35.9%	29.0%	28.0%	--	30.5%
Minor Collector	7.0%	39.7%	28.9%	105.6%	50.5%	42.1%
Ramp	14.5%	57.9%	24.1%	--	--	27.0%
Local Streets	--	54.0%	127.9%	40.0%	--	66.8%
Interchange Ramps	--	--	--	--	--	--
Total	19.5%	32.1%	31.5%	22.2%	28.4%	27.4%

P.M. Directional % Root Mean Square Error

	Rural	Residential	Neigh. Comm.	Heavy Comm.	CBD	Total
Freeway	21.8%	11.6%	--	--	--	16.0%
Major Arterial	13.6%	46.7%	17.8%	18.1%	29.7%	20.6%
Minor Arterial	41.3%	24.8%	38.1%	19.5%	19.0%	30.8%
Major Collector	69.4%	40.6%	39.3%	52.4%	--	44.6%
Minor Collector	88.0%	48.6%	64.8%	94.5%	59.0%	55.9%
Ramp	14.5%	57.9%	24.1%	--	--	27.0%
Local Streets	109.6%	96.4%	131.7%	48.1%	--	91.1%
Interchange Ramps	--	--	--	--	--	--
Total	27.5%	37.3%	37.6%	28.4%	32.9%	33.7%

Level of Service



Level of Service Cut Points						
FT	A	B	C	D	E	F
Freeway	0.31	0.50	0.71	0.87	1.00	1.11
Major Arterial	0.51	0.67	0.79	0.90	1.00	1.11
Minor Arterial	0.51	0.67	0.79	0.90	1.00	1.11
Major Collector	0.51	0.67	0.79	0.90	1.00	1.11
Minor Collector	0.51	0.67	0.79	0.90	1.00	1.11
Ramp	0.51	0.67	0.79	0.90	1.00	1.11
Fwy / Fwy Ramp	0.31	0.50	0.71	0.87	1.00	1.11

LOS patterns generally reflect people's experience

Future conditions: Land Use

- Build Out
  - A set of build out land use conditions based on the recently adopted regional plan and a control total population of 150,000 has been developed.
  - A dozen place-types with population density and job intensity assumptions were distributed across the region in rough compliance with the plan and guidance from local planning staff.
  - Place-type assumptions are converted into a limited set of FMPO Land Use Model codes: Single family attached, detached and multi-family; neighborhood commercial, general commercial, office and heavy and light industrial.
- Horizon Years
  - A Build Out year is calculated based on Arizona Department of Administration growth rates.
  - Districts in the region are assigned high, medium and low growth rates based on projects in process and local knowledge. All TAZs in the district are assumed to have the same growth rate.
  - Interpolations based on relative growth rates between existing conditions to build out are made for years 2020, 2030 and 2040

Future Conditions: Network and Modal LOS

- TIA
  - Existing and committed
- Build Out
  - Network: All planned roadway facilities, especially those assumed as in service to and built by new development, are modeled.
  - Modal LOS: Policy prescription level improvements are assumed to have been made and TAZs are coded accordingly.
- Horizon Years
  - Alternate networks and Modal LOS might be assumed depending on the purpose: Planning or TIA
    - Reasonable expected revenues and a 20-year plan.
    - 1 to 5 year programmed funds